# NISAC

Telecommunications Sector: The AdHopNet Module

NISAC provides advanced modeling and simulation capabilities for the analysis of critical infrastructures and their interdependencies, vulnerabilities, and complexities. These capabilities help improve the robustness of our nation's critical infrastructures by aiding decision makers in the areas of policy analysis, investment and mitigation planning, education and training, and near real-time assistance to crisis response organizations.

The Department of Homeland Security's (DHS) Information Analysis and Infrastructure Protection (IAIP) Directorate is the program office for NISAC. The program's two prime contractors are Sandia National Laboratories (SNL) and Los Alamos National Laboratory (LANL). NISAC integrates the two laboratories' existing expertise in modeling and simulation to address the nation's potential vulnerabilities and the consequences of disruption among our critical infrastructures.

The Urban Infrastructure Suite (UIS) is a set of seven interoperable modules that employ advanced modeling and simulation methodologies to represent urban infrastructures and populations. (See figure at right.) These simulation-based modules are linked to model urban transportation, telecommunications, public health, energy, financial (commodity markets), and water-distribution infrastructures and their interdependencies.

The AdHopNet Module is a scalable, end-to-end simulation environment for representing and analyzing extremely large, complex telecommunication networks made up of cellular networks, public switched telephone networks (PSTNs), Internet (IP) networks, and ad hoc mesh networks. In the figure at right, the AdHopNet module is marked in purple.

At one end of the spectrum, AdHopNet constructs detailed representations of network loads based on individual device usage and real survey data. At the other end of the spectrum, AdHopNet employs signal-theoretic methods for analysis and storage of the vast amounts of data generated during telecommunication simulations. AdHopNet is being developed to fill the technology gap that exists in (1) advanced methods for design, analysis, and development of current and future telecommunication networks and (2) infrastructure-interdependency-aware analytical tools for wireless and wire line networks.
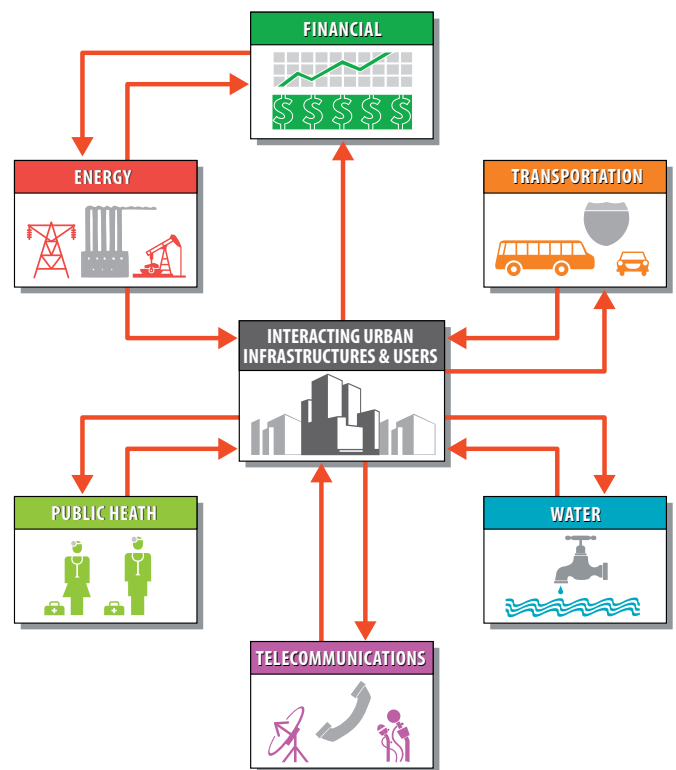
The relationships between AdHopNet (in purple) and the other UIS modules.
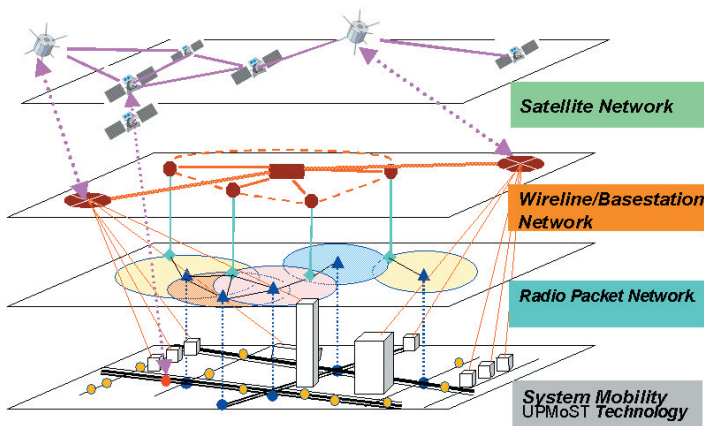
AdHopNet can model nearly any type of telecommunications network. As shown here, AdHopNet uses the UPMoST module to model the mobilities of individuals with phones and then generates phone calls between the individuals. The calls are routed through cell-phone, radio-packet, fixed phone-line, or even satellite networks.

Key Features When configured as part of the UIS, AdHopNet receives demographic, mobility, and device ownership information from the Interacting Urban Infrastructure and Users (UPMoST) module for individuals in a synthetic population. Deriving network loads from this type of high-resolution, dynamic population data, integrated with details of the built urban infrastructure and constraints arising from other UIS sectors, e.g., power outages reported by the Financial (Marketecture) and Energy (IEISS) modules, provides the following advantages:

• AdHopNet is interoperable with other infrastructure simulations that are integrated with the UIS system architecture, permitting interdependency-analysis studies.

• AdHopNet contains modules capable of efficiently storing the large amounts of packet data generated by our telecommunications simulations.

This feature allows us to perform behavioral calibration and validation of communication networks and associated simulations.

• AdHopNet is specifically designed to scale to 10 million nodes in the short term and 1 billion nodes in the long term. It is also designed for technological scaling.

• AdHopNet can be used to evaluate federal policies on the use and operation of telecommunication infrastructures, especially regarding the potential effects of the policies on national security.

• AdHopNet is designed to discover and respond to new vulnerabilities that could occur during the deployment of ad hoc networks, i.e., networks of mobile radio devices that present a constantly evolving telecommunication network.
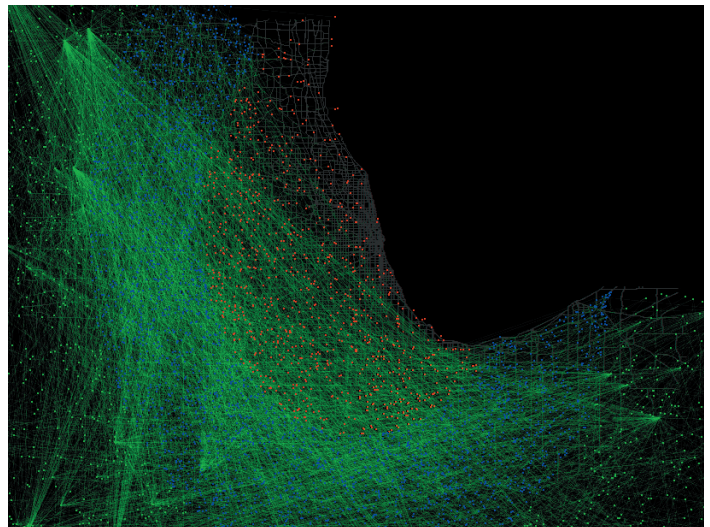
In this plot of Internet traffic in and near Chicago, the red, blue, and green dots are Internet nodes within, bordering, and outside of Chicago, respectively. The bright green lines are Internet connections such as electrical and fiber-optic cables. The faint green lines are streets.

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